# How weather, climate and disturbance alter the hydrological and biogeochemical cycles of semiarid ecosystems

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## Abstract

Compound pressures from climate and climate-driven disturbances including fire and insect infestation alter cycling of water, carbon and nitrogen. Hydrologic changes affect water availability for ecosystems and downstream water resources, impacting physical and biogeochemical ecosystem services. This presentation addresses two questions:

**1) How does ecosystem disturbance alter the amount and quality of water resources?**

We find that fire or insect-driven forest die-off reduce evaporative losses from interception and transpiration by 20-80%, far exceeding direct climate change effects. Surprisingly, our analysis of USGS records in Colorado River headwaters catchments shows streamflow declines are more likely than increases after severe insect disturbance. With observations of soil moisture, snowpack, above-canopy water vapor flux and stable isotopes, we show that increased evaporative losses from the land surface can offset reduced interception and transpiration following disturbance, reducing streamflow. We are developing a new model framework utilizing high-resolution laser mapping to investigate these hydrologic process trade-offs across diverse landscapes.

As plant litter decomposes following insect-driven disturbance, soil water nitrogen increases by several orders of magnitude. However, there is little detectable effect at catchment-scale USGS surface water quality monitoring sites, raising questions for the fate of this nitrogen. Using spatially nested observations, we show that nitrogen flushing to shallow groundwater exceeds USEPA drinking water standards, but more than 90% is removed as groundwater traverses riparian soils and enters the stream, highlighting the role of narrow riparian corridors in buffering disturbance effects.

**2) How important is fast weather variation compared to long-term changes in mean climate in controlling carbon sequestration across ecosystems of the Southwest?**

We use multi-year records of water and $CO_2$ fluxes from 20 eddy covariance sites across the Southwest to show that multi-year mean climate can explain the majority of $CO_2$ exchange between ecosystems and the atmosphere. These results challenge a dominant research paradigm focused on fast (i.e. hourly, daily) ecosystem responses to environmental conditions and highlight the need for improved representation of how gradual climate shifts alter ecosystem function.